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Quality of Petroleum Products: A Case Study of Liberia (September 2015 to December 2015)

Ericson D.F. Karwawhee MSc, MSc, BSc
Department of Petroleum Chemistry, School of Science and Engineering
Atlantic International University ,900 Fort Street 40, Honolulu Hi 96813,USA

SUMMARY
Background: Petroleum is hydrocarbon oil found in suitable rock strata and extracted and refined to produce premium motor spirit (Gasoline), Automotive gas oil (heavy fuel oil), Jet A -1(kerosene), and paraffin.
OBJECTIVE: In this research, the researcher aimed to explore the quality of petroleum products in Liberia form September 2015 to December 2015.
METHODS: Petroleum samples were obtained from drums, tank, and ships from Liberia Petroleum Refining Company (LPRC). BIVAC Liberia Petroleum Laboratory was used to conduct the analysis. Analysis conducted for this study are presented in table one.
RESULTS: Based on the results obtained from Table 2, Table 3, and Table 4 clearly state that petroleum products between the periods September 2015 and December 2015 are in compliant with quality standard of Joint fuelling system check list jet-a1
Embodying the most stringent requirement following specifications for grade shown
(a) British mod def Stan 91-91/issue 7, amendment 1, dated 16 December 2011, JET A1
(b) ASTM D 1655-11b. JET-A1, Issue 27- February 2013 Supersedes issue 26- May 2012 1.
CONCLUSION: This research is the first of its kind in attempting to identify the quality of petroleum products in Liberia. Petroleum is a hydrocarbon oil found in suitable rock strata and extracted and refined to produce premium motor spirit (Gasoline), Automotive gas oil (heavy fuel oil), Jet A 1(kerosene), and paraffin. Petroleum products in Liberia between the periods September 2015 and December 2015 are in compliant with quality standard.
Keywords: Quality, Liberia, Premium motor spirit, Automotive gas oil, Jet A-1, Petroleum products

Table 1: Tests conducted during the study

PROPERTIES	STANDARDS (methods)	Specification 100LL Avgas
Color	Visual	Blue
Distillation		
INITIAL BOILING POINT	ASTM D 86	Report
10% Vol.	ASTM D 86	Max 75.
40 % Vol.	ASTM D 86	Min 75
50% Vol. °C	ASTM D 86	Max. 105
90% Vol. °C	ASTM D 86	Max 135
Final boiling point °C	ASTM D 86	Max. 170
The sum of 10% and 50%	ASTM D 86	135 min
Recovery % Vol.	ASTM D 86	Min 97
Residue % Vol.	ASTM D 86	1.5
Loss %	ASTM D 86	1.5
Gravity API	ASTM D 1298	Report
Copper corrosion, indices. (3h at 50 °C)	ASTM D 130	lb max
Existence gum mg/100ml	ASTM D 381	Max. 3
Electrical conductivity Cu (Ps/m) @ 28.1	ASTM D 2624	Min 50 – Max 450
Reid Vapor press	ASTM D 323	5.5 to 7.0
Freeze point	ASTM D 2386	Max -58

***American Society for Testing and Materials (ASTM)**

INTRODUCTION

Liberia is in West Africa. Liberia covers 96,320 square kilometers of land and 15,049 square kilometers of water, making it the 104th biggest nation in the world with a total area of 111,369 square kilometers. Liberia was founded in 1847. The population of Liberia is 4,299,944 (July 2016) and the nation has a density of forty people per square kilometer ((Karwawhee ***et***,2016). Liberia shares land borders with three countries: Cote d' Voire, Guinea, and Sierra Leone (Nyemah ***et al.,*** 2014).

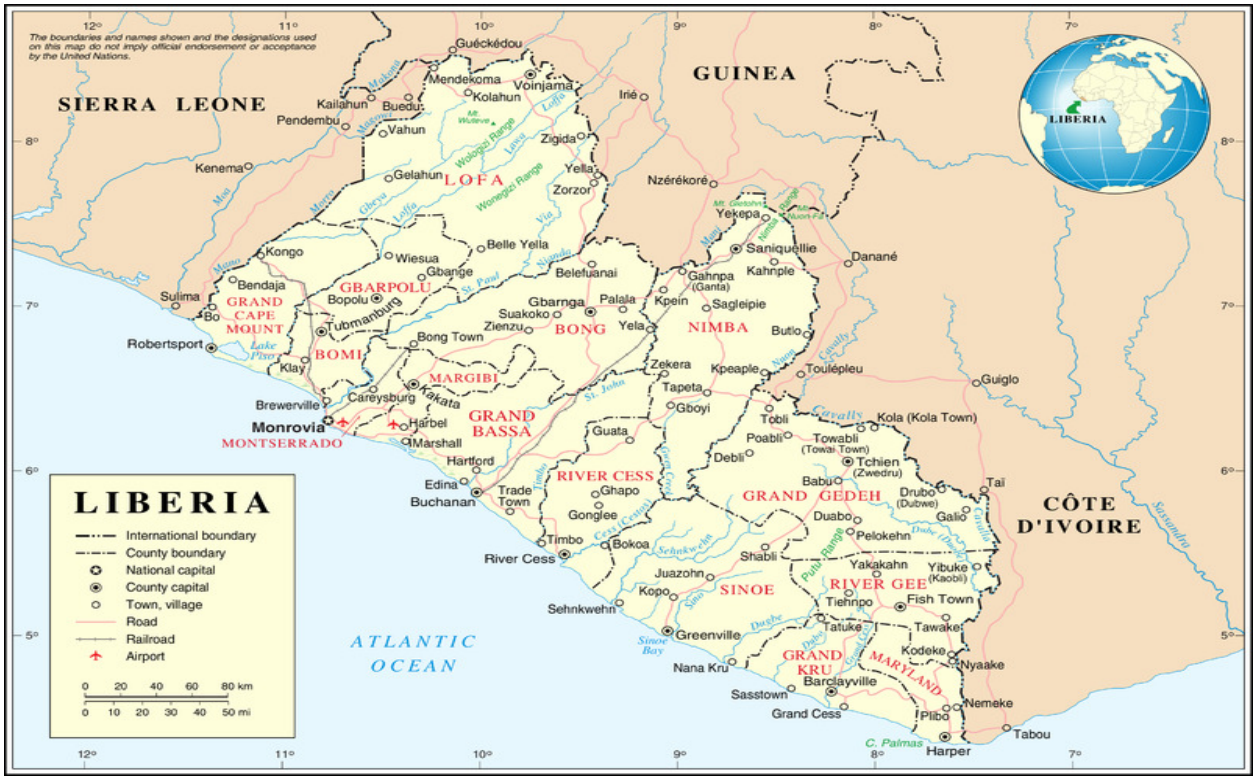

Figure 1: Map of Liberia showing the land borders with three countries

Petroleum products (oil and gas) are inveterate resources of outstanding economic importance (S. W. Longworth, 2007). Petroleum provides about 60% of all the energy used by Liberian (Knight ,2013 quated in Karwawhee ***et al*****,** 2016). Petroleum is used in the production of plastics, fertilizers, detergent, and synthetic fabrics (Dougherty ,2007). Petroleum is formed by hydrocarbons (a hydrocarbon is a compound made up of carbon and hydrogen) with the addition of certain other substances, primarily sulphur. Petroleum in its natural form when first collected is usually named crude oil, and can be clear, green or black and may be either thin like gasoline or thick like tar. The composition of petroleum contains many trace elements. The key compounds are carbon (93% – 97%), hydrogen (10% - 14%), nitrogen (0.1% - 2%), oxygen (01.% - 1.5%) and sulphur (0.5% - 6%) with a few trace metals making up a very small percentage of the petroleum composition. The actual overall properties of each different petroleum source are defined by the percentage of the four main hydrocarbons found within petroleum as part of the petroleum composition. The percentages for these hydrocarbons can vary greatly, giving the crude oil a quite distinct compound personality depending upon geographic region. These hydrocarbons are typically present in petroleum at the following percentages: paraffins (15% - 60%), napthenes (30% - 60%), aromatics (3% to 30%), with asphaltics making up the remainder. The composition of petroleum is defined as the composition which gives the crude oil its properties. Raw petroleum is usually dark brown or almost black although some fields deliver a greenish or sometimes yellow petroleum. Depending upon the field and the way the petroleum composition was formed the crude oil will also differ in viscosity (**http://ericsond-f-karwawhee.simplesite.com/, 2014**).

Heavy crude varies by region and by the organization making the determination. In general, if it has an API (American Petroleum Institute) gravity less than 20, it is considered heavy. At an API gravity of 10, crude oil will have the same density as water. Any API below 10 and the crude sinks in water rather than floating. Oils with an API in this range are often called extra heavy oils.

METHODS

The research was a case study aimed to collecting petroleum samples from ships, drums, and tanks during the period of September 2015 to December 2015. BIVAC- Liberia Petroleum Laboratory was used to investigate the quality of petroleum products in Liberia. Margin of error for this study is 5%, confidence Interval is 95%, and the p- value is 0.05. Letter of authorization was obtained to conduct the experiments.

RESULTS

Table 2 presents the results for premium motor spirit (Gasoline). Table 3 shows the results for Jet A – 1(Kerosene), and Table 4 presents the results for automotive gas oil (heavy fuel oil).
Joint fuelling system check list jet-a1

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Sampling date: September 10, 2015

FROM: DRUMS

Table 2: Analysis of PMS (Gasoline)

PROPERTIES	STANDARDS (methods)	RESULTS	Specification 100LL Avgas
Color	Visual		Blue
Distillation			
INITIAL BOILING POINT	ASTM D 86	41	Report
10% Vol.	ASTM D 86	72	Max 75.
40 % Vol.	ASTM D 86	98	Min 75
50% Vol. ^{o}C	ASTM D 86	102	Max. 105
90% Vol. $_{o}$C	ASTM D 86	115	Max 135
Final boiling point ^{o}C	ASTM D 86	163	Max. 170
The sum of 10% and 50%	ASTM D 86	174	135 min
Recovery % Vol.	ASTM D 86	98.8	Min 97
Residue % Vol.	ASTM D 86	0.6	1.5
Loss %	ASTM D 86	0.6	1.5
Gravity API	ASTM D 1298	52.6	Report
Copper corrosion, indices. (3h at 50 % ^{o}C)	ASTM D 130	1	lb max
Existence gum mg/100ml	ASTM D 381	1	Max. 3
Electrical conductivity Cu (Ps/m) @ 28.1	ASTM D 2624	107	Min 50 – Max 450
Reid Vapor press	ASTM D 323	6.2	5.5 to 7.0
Freeze point	ASTM D 2386	-50	Max -58

Observation: The product complies with the specifications details above

FROM :TK 406

Sampling Date: October 15, 2015

Table 3: Analysis of Jet A - 1

PROPERTIES	STANDARDS METHODS	RESULTS	Limited specifications JET A- Check list
Appearance	Visual	CLEAR & BRIGHT	Clear, bright and visually free from Solid matter and undeserved Water at ambient temperature
Distillation			
Initial boiling point ^{o}C	ASTM D 86	154	Report
10% vol. ^{o}C	ASTM D 86	175	Maxi. 205.0
50% vol. ^{o}C	ASTM D 86	198	Report
90% vol. ^{o}C	ASTM D 86	228	Report
Final boiling point ^{o}C	ASTM D 86	248	Max 300
Residue %	ASTM D 86	1.0	Max 1.5
Loss % vol. ^{o}C	ASTM D 86	1.0	Max 1.5
Density 15 ^{o}C	ASTM D 1298	0.8044	Mini 0.775-maxi 0.840
Flash point ^{o}C	ASTM D 3828	45	Mini 38.0
Freezing point ^{o}C	ASTM D 2386	-51	Max -47
Copper corrosion, indice. (2h at 100 ^{o}C)	ASTM D 130	1a	Max 1
Smoke point	ASTM D 1322	21.7	Min 19
Existence gum mg/100ml	ASTM D 381	1	Max 7
Micro –separometer (MISEP)	ASTM D 3948	94	Min 70
Water reaction	ASTM D 1094	1b	Max 1b
Electrical conductivity Cu (Ps/m) @ 30.0	ASTM D 2624	208	Min 50-max 600

Observation: Based on the sample (s) drawn the product complies with the specification detailed above.

From: ship Sample
Sample Date: December 28, 2015
Table 4: ANALYSIS Of GASOIL

Properties	Standards (methods)	Results	Limited specifications Gasoil
Color	ASTM D 1500		MAXI 3.0
Distillation	ASTMD 86		
Initial boiling point^{oC}	ASTMD 86	181	Report
10% vol. ^{o}	ASTMD 86	239	Report
20% vol. ^{oC}	ASTMD 86	261	Report
50% vol. ^{oC}	ASTMD 86	300	Report
90% vol. ^{oC}	ASTMD 86	361	Report
Distillation at 362	ASTMD 86	90.0	Min 90 .0
Final boiling point ^{o} C	ASTMD 86	392	Report
Residue %	ASTMD 86	1.2	Max 1.5
Loss % vol.	ASTMD 86	1.0	Max 1.5
Density 15 ^{oC}	ASTMD 1298	0.8729	Min 0.8820- max 0.880
Copper corrosion indices. (3h at 50 ^{oC})	ASTMD 130	1a	Max 1b
Flash point (MP)	ASTMD 93	79	Min 66
Water by distillation %	ASTMD 95	< 0.05	Max 0.05
Sediment by extraction %	ASTMD 473	< 0.01	Max 0.01
Conradson Carbon residue %	ASTMD 189	0.04	Max 0. 15
Cetane index calculate	ASTMD 4737	52	Min 45

Observation: The product complies with the specifications details above.

DISCUSSION

Color is not always a reliable guide to product quality and should not indiscriminately in product specification. Determination of color of petroleum products is mainly for manufacturing control purposes and is an important quality characteristic since color is readily observed by the user of the product (S. W. Longworth, 2007).

In some cases the color may serve as an indication of the degree of the refinement of the material. When the color range of particular product is known a variation outside the established range may indicate possible contamination with another product. The product is in the range of marine diesel (Dougherty ,2007). Distillation is a commonly used method for purifying liquids and separating mixtures of liquids into their individual components. Familiar examples include the distillation of crude fermentation products such as gasoline and heating oil (***Www.energyandsecurity.com/liberia.html*****,** 2016). The distillation is a process of heating a liquid to the boiling point, then allowing it to condense in order to collect molecules of different sizes (**http://ericsond-f-karwawhee.simplesite.com/, 2014**).

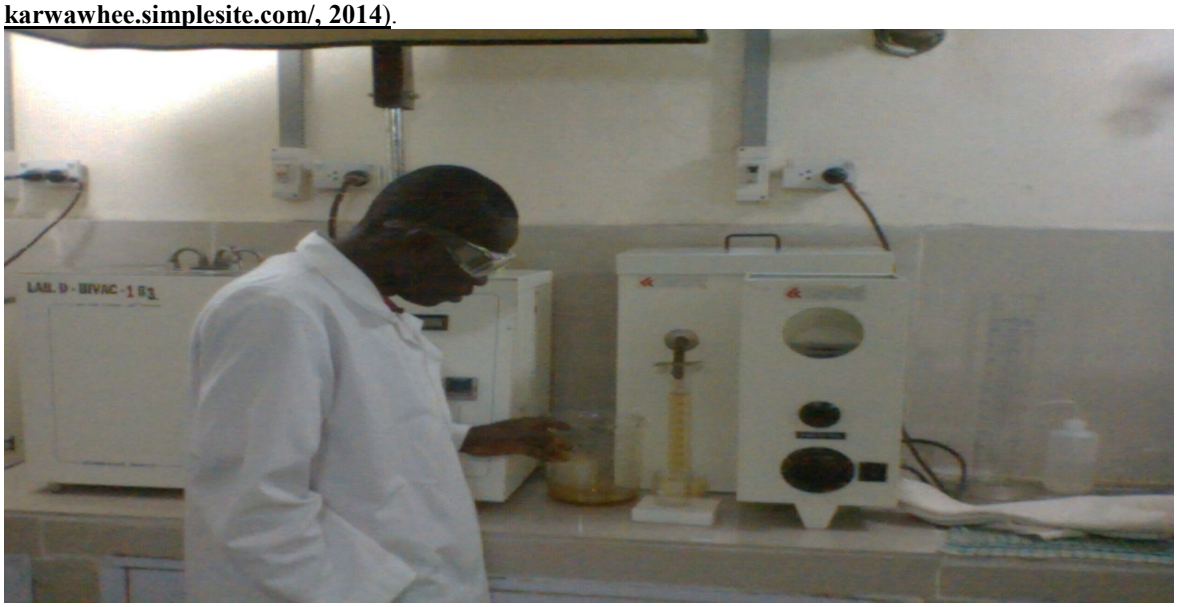

Figure 2: Distillation process

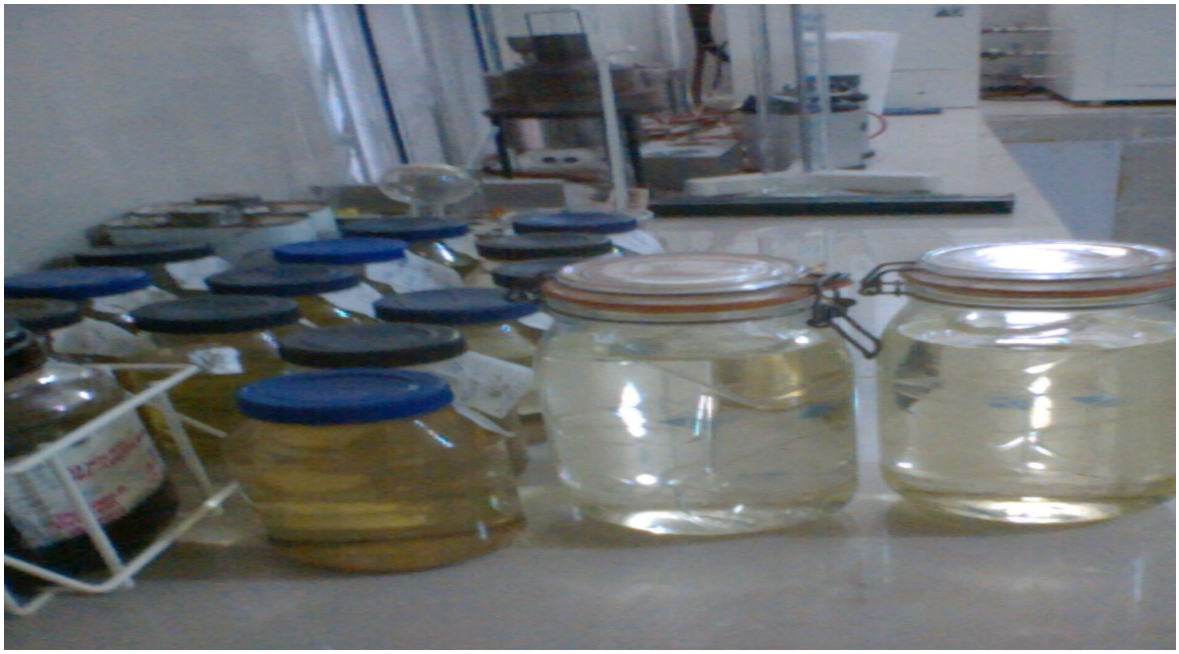

Figure 1: Samples collected for analyse

Flash point is the lowest temperature corrected to pressure of 760mmHg (101.3Kpa) at which application of a test flame causes the vapors of a specimen of the sample to ignite under specified condition of test (***Www.energyandsecurity.com/liberia.html***, 2016). The flash point is the lowest temperature at which a liquid will generate sufficient vapor to ignite (**http://ericsond-f-karwawhee.simplesite.com/, 2014**).

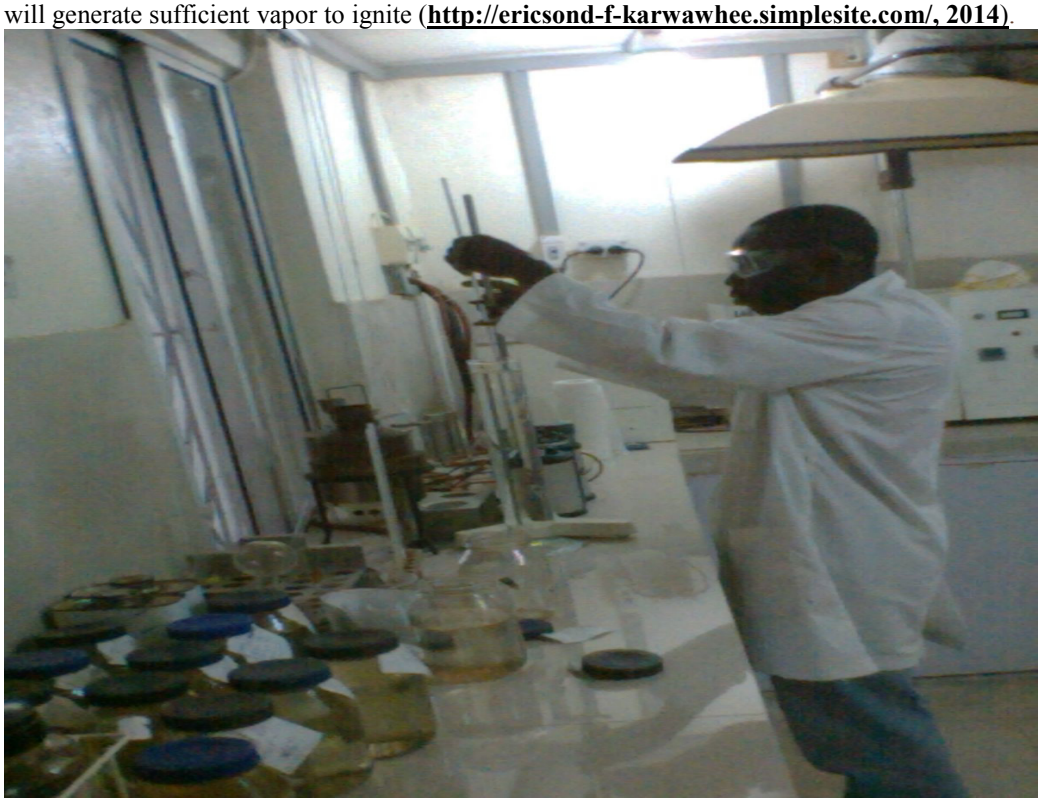

Figure 2: Density Analysis

The density of petroleum is mass of a unit of volume. It is often expressed as mg/L. Liquid petroleum gas or liquefied petroleum gas (LP gas or LPG) referred to as simply propane or butane are flammable mixtures of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and vehicles. It is increasingly used as an aerosol propellant and a refrigerant. It is used as chlorofluorocarbons to reduce damage to the ozone layer. Liquid petroleum gas or liquefied petroleum gas is called autogas when used as a vehicle fuel.

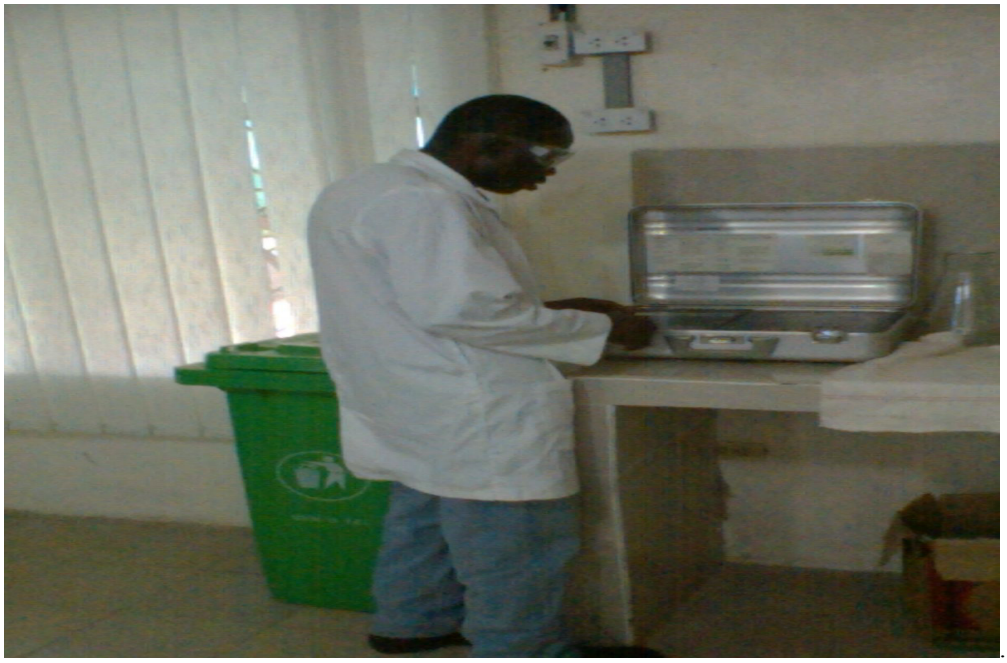

Figure 4: Flash Point

The fire point of a fuel is the temperature at which it will continue to burn after ignition for at least 5 seconds. At the flash point, a lower temperature, a substance will ignite, but vapor might not be produced at a rate to sustain the fire.

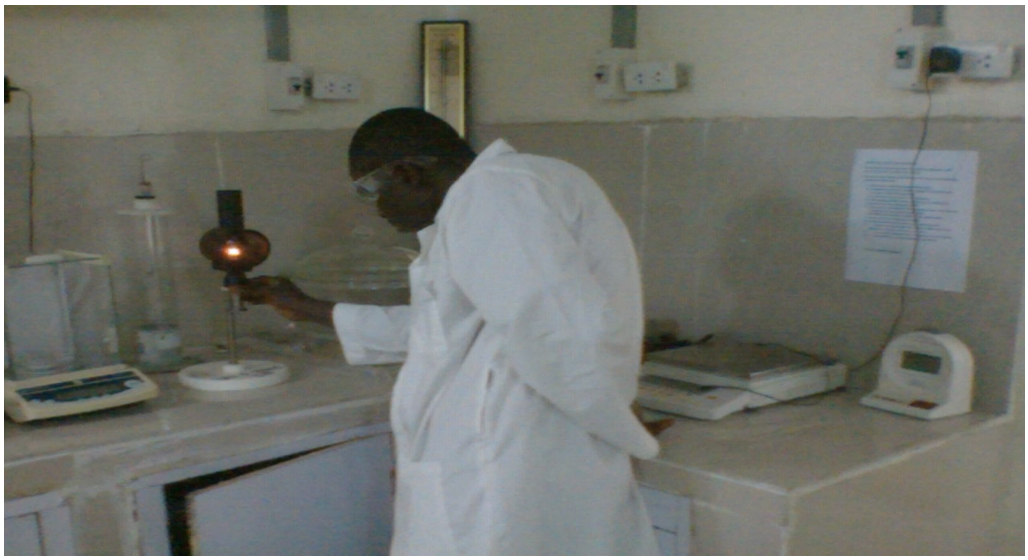

Figure 5: Smoke point analysis

The smoke point is the highest flame height in millimeters at which jet A -1 will burn without smoking. Tested under standard conditions, this test method provides an indication of the relative smoke producing properties of jet A -1 and aviation turbine fuels in a diffusion flame.

CONCLUSION

Petroleum is a naturally occurring crude oil consisting of a complex mix of hydrocarbons of various molecular weights and other liquid organic compounds as well as inorganic compounds**.** Petroleum is a hydrocarbon oil found in suitable rock strata and extracted and refined to produce premium motor spirit (Gasoline), Automotive gas oil (heavy fuel oil), Jet A 1(kerosene), and paraffin. ASTM is an American Society for Testing Materials. This is the group that develops products for testing grade of petroleum products. API gravity is the standard by which all crude oils are measured. API gravity is used to determine the specific gravity of crude oil and its density. This research is the first of its kind in attempting to identify the quality of petroleum products in Liberia. Based on the results obtained from Table 2, Table 3, and Table 4 clearly state that petroleum products between the periods September 2015 and December 2015 are in compliant with quality standard of Joint fuelling system check list jet-a1

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